

Western Electric Co., Incorporated,  
Equipment Engineering Branch, Hawthorne.

(1 Page, Page #1)  
Appendix #5.  
Issue 1 BT 501003 (\*)  
July 18, 1923.

*No Print*

METHOD OF OPERATION

LINE FINDER AND DISTRICT SELECTOR CIRCUIT

Including Line Circuit, Trip Circuit, Starting Circuit, Time Alarm Circuit -  
For Flat or Individual Message Rate Lines - Full Mechanical Power Driven  
System.

Cancel circuit requirements on page 29 to 35 inclusive.

Cancel Appendix #1.

Cancel circuit requirements on page 2 Appendix 2.

Cancel Appendix #3.

Cancel Appendix #4.

ENG.--AFH.  
July 18, 1923.  
BS

CHK'D.--J.I.

APP'D.--H. L. MOYNES,  
E. R. C.



1 page, page 411  
Appendix 42.  
June 1st 1932  
July 1st 1932

Equipment Engineering Branch, Incorporated.  
Equipment Engineering Branch, Incorporated.

REPAIRS AND DISTRICT BELTING CIRCUIT  
Including line circuit, starting circuit, time alarm circuit -  
for that of individual houses (see lines - full mechanical power driven  
system).

The circuit requirements for the line circuit are as follows:

- General circuit requirements on page 42 to 43 inclusive.
- General Appendix 41.
- General circuit requirements on page 44 to 45 inclusive.
- General Appendix 42.
- General Appendix 43.
- General Appendix 44.

APP'D BY - H. J. MOYERS  
F. R. O.

CHIEF - J. J.

RECEIVED  
JULY 18, 1932  
82



Western Electric Company, Inc.,  
Engineering Dept.,  
New York.

(1 Page) Page #1.  
Appendix #4.  
Issue 1 - BT-501003.  
February 27, 1923.

METHOD OF OPERATION

PANEL LINE FINDER

Line Finder and District Selector Circuit Including Line Circuit, Trip Circuit, Starting Circuit - Time Alarm Circuit - For Flat or Individual Message Rate Lines - Full Mechanical Power Driven System.

This appendix was prepared from issue 42 of drawing T-501003.

The Circuit Requirements for the F10 relay shall be changed to read as follows:

After operating on .047 amp., must remain operated when circuit is opened for a minimum period of 0.1 second and release on open circuit within a time interval of maximum 0.35 second.

ENG.--TPI-KX.

CHK'D.--WCD-CWP.

APP'D.--J. L. DOW - G.M.L.



11-7-52  
New York  
January 27, 1953  
T-501003

Western Electric Company, Inc.  
New York  
New York

METHOD OF OPERATION  
PAPER LINE SYSTEM

The circuit is designed to receive and transmit signals in the form of pulses. The circuit is designed to receive and transmit signals in the form of pulses. The circuit is designed to receive and transmit signals in the form of pulses.

This appendix was prepared from the data of drawing T-501003.

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APP'D - J. L. DOW - G.K.L.  
ENCLOSURE  
T-501003



Western Electric Company, Inc.,  
Engineering Dept.,  
New York.

(2 Pages) Page #1.  
Appendix #3.  
Issue 1 - BT-501003.  
November 3, 1922.

METHOD OF OPERATION  
LINE FINDER AND DISTRICT SELECTOR CIRCUIT  
Including Line Circuit, Trip Circuit, Starting Circuit, Time Alarm Circuit -  
For Flat or Individual Message Rate Lines - Full Mechanical Power Driven  
System.

The requirements for 178-AK, E901 and E1187 relays shall be changed  
to read as follows:-

CIRCUIT REQUIREMENTS

THE READJUST REQUIREMENTS SHOWN BELOW ARE FOR MAINTENANCE USE ONLY

	<u>OPERATE</u>	<u>NON-OPERATE</u>	<u>RELEASE</u>
178-AK	Special requirements to insure slow release.		
(D)	Normally closed contact minimum 15 grams.		
Pri.Wdg.	Readj. .044 amp.		Readj. .004 amp.
(500 ohms)	Test .047 amp.		Test .0038 amp.
Sec.	Test .046 amp.		
(500 ohms)			
E901	Special requirements to meet testing conditions.		
(L)	Armature travel .020".		
	Contact pressure 20 grams.		
	Requirements with relay cover off.		
	Readj. .018 amp.		Readj. .0052 amp.
	Test .019 amp.		Test .0049 amp.
	Requirements with relay cover on.		
	Test .019 amp.		Test .0046 amp.
E1187	Special requirements to meet testing conditions.		
(CO)	Armature travel .015".		
	Contact pressure 20 grams.		
Wdgs.	Requirements with relay cover off.		
in se-	Readj. .011 amp.	Readj. .0074 amp.	
ries	Test .017 amp.	Test .007 amp.	



Page 1 - 20/1005  
November 2, 1952

Western Electric Company, Inc.  
Engineering Dept.  
New York

# METHOD OF OPERATION

The following five points are to be observed in the operation of the relay: (1) The relay is to be operated by the line circuit, Trip Circuit, Starting Circuit, Time Limit Circuit, or Stop or Locking Circuit. (2) The relay is to be operated by the line circuit, Trip Circuit, Starting Circuit, Time Limit Circuit, or Stop or Locking Circuit. (3) The relay is to be operated by the line circuit, Trip Circuit, Starting Circuit, Time Limit Circuit, or Stop or Locking Circuit. (4) The relay is to be operated by the line circuit, Trip Circuit, Starting Circuit, Time Limit Circuit, or Stop or Locking Circuit. (5) The relay is to be operated by the line circuit, Trip Circuit, Starting Circuit, Time Limit Circuit, or Stop or Locking Circuit.

The requirements for 178-AK, 2901 and 21187 relays shall be changed to read as follows:

## RELAY REQUIREMENTS

THE RELAY REQUIREMENTS ABOVE ARE FOR MAINTENANCE USE ONLY

### RELEASE

### FOR OFF-STATE

### OPERATE

178-AK Special requirements to insure slow release.  
(1) Normally closed contact minimum 15 grams.  
Test: 0.004 amp.  
Test: 0.005 amp.

2901 Test: 0.04 amp.  
(100 ohms)

21187 Special requirements to meet testing conditions.  
Armature travel: 0.03".  
Contact pressure: 20 grams.

Requirements with relay cover off.  
Test: 0.015 amp.  
Test: 0.015 amp.

Requirements with relay cover on.  
Test: 0.015 amp.

Special requirements to meet testing conditions.  
Armature travel: 0.015".  
Contact pressure: 20 grams.

Requirements with relay cover off.  
Test: 0.015 amp.  
Test: 0.015 amp.



(2 Pages) Page #2.  
Appendix #3.  
Issue 1 - BT-501003.  
November 3, 1922.

CIRCUIT REQUIREMENTS

THE READJUST REQUIREMENTS SHOWN BELOW ARE FOR MAINTENANCE USE ONLY

	<u>OPERATE</u>	<u>NON-OPERATE</u>	<u>RELEASE</u>
Inner Wdg. (100 ohms)	Test .078 amp.	Test .039 amp.	
Wdgs. in series	Requirements with relay cover on. Test .017 amp.	Test .0066 amp.	
Inner Wdg. (100 ohms)	Test .078 amp.	Test .037 amp.	

ENG.--RR-KX.

CHK'D.--LBS-CWP.

APP'D.--J.L.DOW - GML.



1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

# THE FOLLOWING INFORMATION IS FOR YOUR INFORMATION ONLY

1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

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2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

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3. Page 1, line 14.  
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3. Page 1, line 14.  
4. Page 1, line 15.

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2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

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2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.

1. Page 1, line 12.  
2. Page 1, line 13.  
3. Page 1, line 14.  
4. Page 1, line 15.



METHOD OF OPERATION  
LINE FINDER AND DISTRICT SELECTOR CIRCUIT

Including Line Circuit - Trip Circuit - Starting Circuit - Time Alarm for Flat or Individual Message Rate Lines - Full Mechanical Power Driven System.

UNDER DETAILED DESCRIPTION

The third sentence from the last of paragraphs on page 5, should read as follows:-

"The GA relay operated, removes ground from lead ST, closes lead K, locks to ground on the armature of the STA relay, and closes a circuit operating the STP-A magnet".

Add the following to paragraph 8.

"Should the STA or STB relay remain operated due to failure of the K segment ground shunting and releasing the TR or TR-1 relay in the trip circuit, the KF relay operates when interrupter contacts I, III and V of the 149-J interrupter close, and locks to the STA or STB relay. If the relay stays locked for two seconds, interrupter contacts II and IV connect ground to either the TR or TR-1 relay, thereby releasing the TR or TR-1 relay. When ground is removed by the opening of interrupter contacts II or IV relay STA or STB releases, releasing the KF relay and restoring the circuit to normal. The closing of interrupter contact VI at the time relay KF is operated, operates the KA relay, which locks through to a key in the trouble desk, lighting a lamp and operating an alarm. The operation of the key releases the KA relay, extinguishing the lamp and silencing the alarm".

Paragraph 48 on page 26 should be changed to read as follows:

48. Should the selector travel to the tell tale position during brush selection, ground on the X commutator brush and segment is connected through cam B to battery through the R magnet, advancing the switch to position 8. Under this condition, ground is disconnected from the SC lead in the sender, releasing the CH relay and the district remains in position 8 until it is restored to normal manually. If the district goes to tell tale during group selection ground on the X commutator advances the switch to position 8. In position 8, ground on the SC holds the CH relay operated which, in turn operates the L relay advancing the switch to position 9. The CH and L relays remain operated and the district remains in position 9 until it is restored to normal manually.

Under circuit requirements omit the requirements for the E639 relay, (GA) and (GB) and add the requirements for the E6000 (GA and GB) E725 (KF), and E1626 (KA) relays.







CIRCUIT REQUIREMENTS

THE READJUST REQUIREMENTS SHOWN BELOW ARE FOR MAINTENANCE USE ONLY

OPERATE

NON-OPERATE

RELEASE

Change the requirements for the E638 (ST-B) and E899 (ST-A) to read as follows:

E638 (ST-B)	Special requirements to insure fast operation. Through relay winding. Readj. .025 amp. Through parallel combination with the 18-BH resistance. Readj. .039 amp. Test .042 amp.	Through relay winding. Readj. .004 amp. Through parallel combination with the 18-BH resistance. Readj. .0062 amp. Test .0059 amp.
E899 (ST-A)	Special requirements to insure fast operation. Through relay winding. Readj. .026 amp. Through parallel combination with the 18-BH resistance. Readj. .041 amp. Test .044 amp.	Through relay winding. Readj. .005 amp. Through parallel combination with the 18-BH resistance. Readj. .077 amp. Test .0073 amp.
E725 (KF)	Readj. .017 amp. Test .019 amp.	Readj. .002 amp. Test .001 amp.
E1626 (KA)	Readj. .010 amp. Test .016 amp.	Readj. .001 amp. Test .0005 amp.
E6000 (GA)(GB)	Special requirements to insure fast operation. Armature travel .035" + or - .0025". Readj. .018 amp. Test .019 amp.	The contact pressure of the normally closed contacts shall be minimum 20 grams. The contact pressure of all other contacts shall be minimum 15 grams.

ENG.--RJH-BH.

CHK'D.--WCD-CWP.

APP'D.--C.L. SLUYTER, GML.







Western Electric Co., Incorporated,  
Engineering Dept.,

(1 Page) Page #1.

Appendix #1.

Issue 1 - BT-501003.

Appendix Sept. 9, 1921.

#### METHOD OF OPERATION

##### Line Finder And District Selector Circuit

Including Line Circuit - Trip Circuit - Starting Circuit - Time Alarm Circuit -  
For Flat or Individual Message Rate Lines - Full Mechanical Power Driven  
System -

Page 36

Requirements for the E-1187 relay should be changed to read as follows:

	<u>OPERATE</u>	<u>NON-OPERATE</u>
E1187	(Special Requirements to meet testing conditions)	
(CO)	Readj. .011 amp.	Readj. .0074 amp.
Wdgs.	Test .017 amp.	Test .007 amp.
Series	W.C.C. .0325 amp.	
aiding		
Inner	Test .078 amp.	Test .039 amp.
Wdg.	W.C.C. .134 amp.	
(100 ohms)		

ENG.---JLS-JO.

CHK'D.---ASP-GWP.

APP'D.---C.L. SLUYTER, C.M.L.



# METHOD OF OPERATION

1. The following is a description of the method of operation of the device.

2. The device is a simple circuit consisting of a transformer, a rectifier, and a filter.

3. The transformer is a step-down transformer with a primary voltage of 115V and a secondary voltage of 0-250V.

4. The rectifier is a full-wave bridge rectifier consisting of four diodes.

5. The filter is a simple RC filter consisting of a resistor and a capacitor.

6. The output voltage of the device is adjustable by means of a potentiometer.

## TEST RESULTS

7. The following table shows the results of the tests conducted on the device.

8. The test results show that the device is capable of operating at a load of 100W.

9. The test results also show that the device is capable of operating at a load of 200W.

10. The test results show that the device is capable of operating at a load of 300W.

11. The test results show that the device is capable of operating at a load of 400W.

12. The test results show that the device is capable of operating at a load of 500W.

13. The test results show that the device is capable of operating at a load of 600W.

14. The test results show that the device is capable of operating at a load of 700W.

15. The test results show that the device is capable of operating at a load of 800W.

16. The test results show that the device is capable of operating at a load of 900W.

17. The test results show that the device is capable of operating at a load of 1000W.

18. The test results show that the device is capable of operating at a load of 1100W.

19. The test results show that the device is capable of operating at a load of 1200W.

20. The test results show that the device is capable of operating at a load of 1300W.

21. The test results show that the device is capable of operating at a load of 1400W.

22. The test results show that the device is capable of operating at a load of 1500W.



#### METHOD OF OPERATION

##### LINE FINDER AND DISTRICT SELECTOR CIRCUIT

Including Line Circuit, Trip Circuit, Starting Circuit, Time Alarm Circuit -  
For Flat or Individual Message Rate Lines - Full Mechanical Power Driven  
System.

#### GENERAL DESCRIPTION

1. This common panel line finder and district selector circuit is used for passing calls originated by a dial subscriber on a flat or individual message rate line. It consists of six functionally connected circuits, as follows:-
  - 1.1 The LINE circuit consists of a line relay (L), cut-off relay (CO), and a message register, one line circuit for each subscriber's line. When the receiver at a calling station is removed from the switchhook, battery is connected to the hunting (H) lead of the calling line and the associated apparatus functions and starts a line finder selector hunting for the battery on the hunting lead. When the calling line is found, battery and ground from the line circuit is disconnected from the tip and ring of the line, which awaits the closure of talking battery from the associated district circuit. The associated trip circuit is also released, thus permitting another call to start in that half of the group.
  - 1.2 A TRIP circuit is provided for each bank group of 20 lines, thus making 15 trip circuits on a panel line finder frame of 300 lines. Each trip circuit is divided into two units, trip unit A, having access to the first 10 lines in a bank, and trip unit B, having access to the last 10 lines in a bank. The trip circuit mechanically trips the selector brushes of the particular bank in which the terminals of its associated lines appear and connect to a starting circuit. Each trip circuit is equipped with an emergency plug and jack, by means of which a defective trip circuit can be immediately replaced by an emergency circuit.
  - 1.3 The STARTING circuit controls the routing of calls to the respective line finder selectors and starts an idle selector hunting over the line terminals for the calling line. It also at the same time releases a trip relay in the associated trip unit, thus permitting another call to start in any other group. There is one starting circuit for each frame of 300 lines. The circuit consists of three 200 type distributing selectors, one of which permits the distributing of this circuit so as to give each line group an equal preference. The other two distributing selectors distribute the



calls uniformly to the respective line finder selectors. Each regular starting circuit is provided with means for testing any line finder circuit and is equipped with an emergency plug and jack for immediately replacing the regular circuit with an emergency circuit at any time.

1.4 The LINE FINDER circuit is arranged to find the calling subscriber's line and connect it with the various switching apparatus necessary to complete a call. Each line finder circuit is permanently connected to a district selector circuit and consists of a power driven selector having 15 sets of contact brushes wired in multiple, one set of brushes associated with each line bank. At the same time the line finder selector starts upward hunting for the calling line, the associated district circuit functions and selects an idle sender. This circuit also includes a MAKE BUSY jack and a TEST jack.

1.5 The DISTRICT SELECTOR circuit, which is the other end of the line finder selector, is provided with a magnet, driven selector switch, by means of which an idle sender is selected and associated with the district until all selections have been completed, when the sender is discharged. The district circuit is selector ended and selects and connects to the proper outgoing trunk, under the control of a sender, for the completion of an originating call. It also supplies talking battery to the calling station, connects battery for the operation of the message register in the line circuit on a charged call, and connects the busy tone to the calling station if required.

1.6 The LINE FINDER TIME ALARM circuit is for the purpose of giving visual and audible signals to the attendant when an originating call is not connected to a line finder in a specified time period.

#### PANEL LINE FINDER FRAME

2. A panel line finder frame consists of 15 banks (at times known as panels) of line terminals, each bank consisting of 20 sets of multiple line terminals, making a total capacity of 300 lines. The multiple terminals appear on both sides of the bank and each set consists of four terminals, namely: tip (T), ring (R), sleeve (S) and hunting (H). Each frame and bank has a capacity of 60 line finder selectors, 30 selectors mounted on the front of the frame and the other 30 selectors mounted on the rear of the frame. This number of selectors for each 300 lines may be reduced to 40 or 28 selectors. The arrangement of the selectors may be accomplished by splitting the line multiple banks of a frame in the following manner:-



- 2.1 Each 60 selector bank on a frame is split in the center and arranged for a cross connecting cable, so that the first or bottom line on one side of the split will connect to and appear at the last or top line on the other half of the bank. This practice is used where 60 line finder selectors are required for each 300 lines.
- 2.2 Each 60 selector bank on a frame is split into three sections of 20 selectors each, two of these sections to be arranged for cross connecting to each other, the other section to be cross connected to a corresponding bank section on another frame. This practice is used where 40 selectors are required for each 300 lines, thus permitting 900 lines to be accommodated on two frames.
- 2.3 A 56 selector bank split into four sections of 14 selectors each, the first and second sections to be arranged for cross connecting to each other and the third and fourth sections arranged for cross connecting to each other. This practice is used where 28 selectors are required for each 300 lines, thus permitting 600 lines to be accommodated on the one frame.
3. Each group of selectors for each 300 lines is divided into two sub-groups, "A" and "B". The "A" sub-group of selectors is on one side of the transposition split and the "B" sub-group is on the other side of the transposition split. By this method, a call originating in a group of 20 lines causes a selector in the "A" or "B" sub-group to start hunting, the sub-group depending upon the calling line being in the first or last 10 lines of the group. Should two calls in the same group originate at the same time, one being in the first 10 lines and the other being in the last 10 lines, two selectors will start, one selector in sub-group "A", the other in sub-group "B". Should all line finders in a sub-group be busy, a call originating within the corresponding 10 lines will start a selector in the adjacent sub-group.
4. When both sub-groups of selectors for 300 lines are on the same frame, two TRIP magnets are used, one magnet on the front and the other magnet on the rear of the frame. When both sub-groups of selectors are on separate frames, four TRIP magnets shall be used, one on the front and one on the rear of each frame.

#### DETAILED DESCRIPTION

##### ORIGINATING CALL

5. The operation for a call originating in the first 10 lines of a group is as follows:- When the receiver is removed from the switchhook



July 7, 1921.

at the calling station, the L relay in the line circuit operates over a circuit from battery through the 200 ohm resistance, winding of the L relay, break contact of the CO relay, over the ring side of the line, through the subscriber's loop, back over the tip side to ground on the armature of the CO relay. The line L relay operated, connects battery to the H terminal of the line at the line finder multiple bank and operates the BA relay through its inner winding. The BA relay operated, operates the TR relay over a circuit from ground on the armature of the BA relay, break contact of the K relay, 700 ohm winding of the TR relay, break contacts of the A, ST-A, and ST-B, relays, to battery on the armature of the STP-G magnet. The TR relay operated performs the following functions: (a) operates the two TRIP magnets from ground on its armature (b) opens the locking series circuit through the TR relays in the other bank groups, as hereinafter described, (c) locks in a circuit from ground through its 600 ohm winding and make contact, terminal 1 and brush of the G group distributor selector, break contacts of the C, CA, and SB relays, to battery through the winding of the ST-A relay, which operates. Each TRIP magnet operates its trip rod, thus tripping the corresponding group brushes of the associated selectors on its respective side of the frame. The ST-A relay operated, functions as follows: (a) closes a circuit from ground on its left inner armature, to battery through the winding of the STP-G magnet, which operates and remains operated until the ST-A relay releases, (b) short circuits the 500 ohm winding of the CA relay, preventing it from operating and starting a line finder in sub-group "B", as described in paragraph 31, while a call is going through, (c) operates the K relay over a circuit from battery through the winding of the K relay, make contact of the TR relay, to ground on the armature of the ST-A relay, (d) closes a circuit operating the LF relay in the line finder circuit. This circuit is traced from ground on the right outer armature and inner make contact of the ST-A relay, through the break contacts of the CA, and C relays, the A1 bridging brush and terminal of the A selector, over lead ST, break contact of the MB relay in the line finder circuit, break springs of the TEST jack, to battery through the 1000 ohm winding of the LF relay. The K relay operated, (a) locks to ground on the armature of the BA relay through its make contact and the break contact of the O relay (b) opens the circuit through the 700 ohm winding of the TR relay, thus preventing another line finder selector from being started by this call, (c) closes a circuit from ground on its make contact through the 1500 ohm winding of the O relay, but the O relay does not operate at this time on account of insufficient amount of current through the winding. The LF relay operated, (a) locks to ground on the break contact and armature of the H relay, through its make contact and both windings in series, (b) closes a circuit operating the CA relay in the starting circuit from ground on the break springs of the Make



*gudon [m]*  
Busy jack, make contact of the LF relay, break contact of the MB relay, lead Y, to battery through the break contact and winding of the GA relay. (c) operates the UP magnet from ground on the ~~H commutator brush and segment~~, causing the line finder selector to travel upward and hunt for the terminals of the calling line to which battery is connected, as herein-after described. (d) closes a circuit from the same ground on the ~~H commutator brush and segment~~, through the break contact of the line finder E relay, to battery through the inner winding of the CI relay, operating the CI relay. The GA relay operated, removes ground from lead ST, locks to ground on the armature of the ST-A relay and closes a circuit operating the STP-A magnet. This circuit is traced from ground on the armature and inner make contact of the ST-A relay, make contact of the GA relay, terminal and brush of the A-3 arc of the A selector, to battery through the winding of the STP-A magnet. The STP-A magnet remains operated until the release of the ST-A relay. *LF relay*

6. As the line finder selector starts upward hunting for the calling line, a circuit is closed through the M commutator slightly after the brushes of the selector move off-normal. Ground on the M commutator brush and segment operates the line finder E relay. The E relay operated, (a) operates the MB relay from ground on its armature, through the break springs of the M.B. jack, to battery through the inner winding of the MB relay, (b) closes a circuit from ground on the upper inner contact of cam I, make contact of the E relay, to battery through the inner winding of the D relay, operating the D relay, (c) opens the operating circuit of the CI relay, thus permitting the relay to release, should the TEST brush of the sender selector be making contact with the TEST terminal of an idle sender. If the TEST brush of the sender selector is making contact with the TEST terminal of a busy sender, the CI relay locks through its outer winding, the lower contacts of cam S, make contact of the relay, to ground on the TEST brush of the sender selector. With the CI relay held operated, the operation of the line finder E relay also closes a circuit operating the F relay in the line finder circuit and the district selector STP magnet. This circuit is traced from battery through the 1000 ohm winding of the F relay and through the winding and break contact of the STP magnet, make contacts of the CI and E relays, to ground on the lower outer contact of cam H, thereby stepping the sender selector brushes one step on its back stroke. If the next sender circuit is idle, the CI relay releases, in turn stopping the selector, but if the next terminal is busy, the CI relay remains operated and the sender selector continues to step until an idle sender is found. When the CI relay releases, the TEST terminal of the selected sender is immediately made busy to all hunting sender selectors by ground connected to the TEST brush from the lower outer contact of cam H, through the make contact of the E relay and the break contact of the CI relay. This busy ground is connected until the switch advances from position 1 1/4. The operation *+ GP*



of the F relay opens the tip and ring leads between the line finder commutator and the district circuit and prevents the district L relay from operating and advancing the district switch from normal, should the line finder selector connect to the terminals of the calling line before the sender selector finds an idle sender.

7. The MB relay operated; (a) locks from ground on the armature and outer make contact of the ST-A relay, lead X, make contact and outer winding of the MB relay, to battery on the break contact and armature of the SL relay, so that the MB relay will not release should the selector return to normal while another call is going through, (b) closes a circuit from ground through the break springs of the MB jack, make contacts of the LF and MB relays, to battery through the 800 ohm winding of the F relay, which operates if the relay was not previously operated, (c) connects ground on its armature to the series circuit through the MB relays of the other selectors in the same group, thus permitting the operation, over lead CH of the CA, or CB relays in the starting circuit when all line finder selectors in the group are off-normal, (d) opens the circuit over lead Y, to prevent the GA relay from re-operating, (e) transfers the ST lead to the next line finder, which if busy, transfers the call over the ST lead in the same manner until an idle line finder is found.
8. As the line finder selector continues upward, at the end of the tripping Zone, ground on the K commutator brush and segment, short circuits the 600 ohm winding of the TR relay through the break contact of the DS relay, over lead K and through the break contact of the SA relay, thus releasing the TR relay. The ST-A relay remains operated from the same ground until the K brush moves off the K commutator segment, when the circuit through the winding of the ST-A relay is opened, releasing the relay. This is before the brushes of the line finder selector have reached the first set of line terminals. The TR relay released, closes the locking series circuit through the TR relays in the other groups and opens the circuit through the two TRIP magnets, which release. The STA relay released, (a) opens the locking circuit through the GA relay, which releases, (b) opens the circuit through the locking (outer) winding of the MB relay, but the relay does not release as it is held operated over its operating circuit, (c) opens the circuit through the STP-A magnet, which releases and steps the brushes of the G group distributor selector to the next terminals, (d) opens the circuit through the STP-A magnet, which releases and steps the brushes of the A group distributor selector to the next terminals, (e) removes the short circuit from the 500 ohm winding of the CA relay, which does not operate unless all selectors in the group are busy as described in paragraph 31.

*See Appendix Revision 2.*



9.

When the selector brushes make contact with the terminals associated with the calling line, battery on the H terminal operates the O relay in the trip circuit and the H relay in the line finder circuit. This circuit is traced from battery in the trip circuit, through the 500 ohm winding of the O relay and the 500 ohms resistance connected in parallel, make contact of the L relay, over lead H, through the H multiple terminal and brush, H commutator brush and segment, outer contacts of cam Y, winding of the H relay, to ground on the break contact and armature of the DS relay. With the H relay operated, a 50 ohm non-inductive shunt is connected around its winding to ground on its armature for the purpose of increasing the amount of current through the 500 ohm winding of the O relay, thus speeding its operation. This is necessary on account of the very short time period when the H brush makes contact with the H terminal before the circuit over lead H, is opened by the overthrow of the selector. The H relay operated, opens the circuit which holds the LF relay operated, but the LF relay does not release immediately on account of a circuit being closed from ground through the C commutator brush and segment, to battery through both windings of the LF relay in series. The LF relay is thus held operated until the brushes are centered on the terminals of the calling line. When the circuit through the C commutator segment is opened, the LF relay releases. The LF relay released, (a) opens the circuit through the UP magnet, which stops the selector brushes on the terminals of the calling line, (b) opens the circuit through the 800 ohm winding of the F relay, so that when the circuit through its 1,000 ohm winding is opened, by the release of the CI relay when the district sender selector seizes an idle sender, the F relay releases, (c) closes a circuit operating the SL relay. This circuit is traced from ground through the break contact springs of the MB jack, break contact of the LF relay, make contact of the E relay, winding of the SL relay, inner contacts of cam T, make contacts of the D relay, to battery on the break contact of the DS relay.

- 9.1 The adjustment of the C commutator brush, with relation to the tripped H multiple brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit through both windings of the LF relay is opened by the operation of the H relay when the H brush makes contact with the H terminal to which battery is connected. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the line terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time and holding circuit through both windings of the LF relay is opened at the C commutator, releasing the relay. The LF relay released, releases the UP magnet. The selector then drops into place, thus centering the brushes on the line terminals.



10. The O relay operated, opens the locking circuit of the K relay. The K relay is very slow in releasing to hold the O relay operated through its 1500 ohm winding, in order to permit the BA relay to release before the O relay, otherwise another line finder may be started by this call.
11. The SL relay operated, closes a circuit which operates the CO relay in the line circuit from battery on its armature, through the two 110 ohm resistances (A and B) in series, over lead S, to ground through one or both windings of the CO relay in series. This same battery is connected to the multiple sleeve terminals of the line at the final frame, making the line test busy to all hunting final selectors on a terminating call. The CO relay operated, releases the line L relay, which in turn releases the BA relay, which opens the circuit through the O and H relays, which release. Another call may now start within this same group of 10 lines if the starting circuit is ready for the call. The operation for a call originating in the last 10 lines of a group of 20 will be similar to that already described for the first 10 lines, except that the BA-1, K-1, O-1, TR-1, ST-B, and GB relays are involved instead of the BA, K, O, TR, ST-A, and GA relays.
12. If there is a simultaneous call in both the first and last 10 lines of a group of 20 lines, the relays of both sub-groups will operate as already described, starting two line finder selectors in different sub-groups at the same time. In this case, the inner windings of the O and O-1 relays are connected together through the make contacts of the BA, and BA-1 relays. The O and O-1 relays will therefore operate in parallel when the H brush of either or both line finder selectors make contact with the H terminal of the calling line.
13. The operation of the SL relay also closes a circuit operating the district L, and CH relays. This circuit is traced from ground on the N commutator brush and segment, through the break contact of the F relay, make contact of the SL relay, lower inner and upper outer contacts of cam O, to battery through the 600 ohm winding of the CH relay. This same ground is connected through the inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the 800 ohm winding of the district L relay. The CH relay operated, closes a circuit from ground on the upper outer contact of cam I, break contact of the CS relay, make contact of the CH relay, to battery through the selector time alarm circuit (not shown), which performs no function at this time. The L relay operated, closes a circuit advancing the district switch to position 2. This circuit is traced from battery through the R magnet, lower



outer contact of cam B, make contact of the L relay, to ground through the lower contacts of cam M. As the switch advances from position 1, the circuit through the L and CH relays is opened, releasing the relays and disconnecting the selector time alarm circuit. In position 1-1/2 to 2, the associated sender is held busy by ground through the upper outer contact of cam H, and the outer contacts of cam C.

14. With the switch in position 2, the tip and ring leads are closed from the calling line to the T and R leads of the associated sender circuit, thus permitting a dialing tone to be transmitted back over the dialing circuit from the associated sender, as an indication that the apparatus is ready to receive the call by the operation of the station dial. The tip side of the dialing circuit is closed from the T lead of the line, through the break contact of the F relay, inner contacts of cam P to the T brush of the sender selector. The ring side of the dialing circuit is closed from the R lead of the line, through the break contact of the F relay, winding of the DC relay, inner contacts of cam Q, to the R brush of the sender selector. In position 2, the CI relay operates through its outer winding to ground on cam I, and remains operated until the switch advances from position 10. The CI relay operated, (a) connects ground through the inner contacts of cam S, to the TEST brush of the sender selector, thus making the associated sender test busy after the switch advances from position 2, (b) closes the tip side of the fundamental circuit through to the sender, (c) closes the sender control (SC) lead through the lower contacts of cam V, lower inner and upper outer contacts of cam U, to battery through the outer winding of the D relay. After the sender functions the fundamental circuit is established for the operation of the district L relay and the stepping relay in the sender. This circuit is traced from ground in the sender circuit, through the FT brush, make contact of the CI relay, inner contacts of cam L, to battery through the 1200 ohm winding of the L relay, which operates. The L relay operated, locks through its 1200 ohm winding and make contact through the upper contacts of cam L to the same ground over the FT lead and advances the switch to position 3 from ground on cam M. In position 3, ground through the lower inner contact of cam H is connected to the FR lead, thus permitting the sender to function. The 500 ohm winding of the CH relay is also connected through the lower contacts of cam U, in parallel with the winding of the D relay, to the SC lead previously described. Should the CH relay operate at this time, due to a high resistance ground in the sender circuit, no useful function will be performed.

#### DISTRICT BRUSH AND GROUP SELECTIONS

15. With the switch in position 3, the UP magnet is operated for brush selection over a circuit traced from battery through the winding of the



July 7, 1921.

magnet, inner contacts of cam C, make contact of the L relay, to ground through the lower contacts of cam M. As the selector moves upward in position 3, carrying the commutator brushes over the commutator segments, the A segment and brush intermittently connects ground to the tip side of the fundamental circuit through cams K and L, holding the L relay operated but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its re-operation until the proper brush has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the L relay. The L relay released, opens the circuit through the UP magnet, thereby stopping the upward movement of the selector and advances the switch to position 4. This circuit is traced from ground through the lower contacts of cam M, break contact of the L relay, upper outer contact of cam B, to battery through the R magnet. When 2 digit senders are used with this circuit, the advance of the sender replaces the high resistance ground on the SC lead with a 500 ohm ground, thus insuring the operation of the CH relay. In position 4, the trip magnet (TM) is operated from ground through the upper contacts of cam S, and the L relay is operated and locked to ground over the fundamental circuit previously described, advancing the switch to position 5.

16. With the switch in position 5, the UP magnet is re-operated and the trip magnet being operated, causes the previously selected set of brushes to trip when the selector starts upward as the set of brushes engage the trip finger which was previously operated by the trip magnet. As the selector moves upward for group selection, carrying the brushes over the commutator segments, the B segment and brush intermittently connects ground to the tip side of the fundamental circuit through cam L, holding the district L relay operated, but successively short circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its reoperation until the proper group has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the L relay which in turn opens the circuit through the UP magnet and advances the switch to position 6. When 3 digit senders are used with this circuit, the advance of the sender replaces the high resistance ground on the SC lead with a 500 ohm ground, thus insuring the operation of the CH relay. With the switch in position 6, a circuit is closed from ground on the line finder N, commutator brush and segment, through the break contact of the F relay, make contact of the SL relay, inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the 800 ohm winding of the L relay, operating the relay. The L relay operated advances the switch to



position 7 in a circuit traced from battery through the R magnet, lower outer contact of cam B, make contact of the L relay, inner contacts of cam M, make contacts of the D relay, to ground through the lower outer contact of cam I.

#### TRUNK HUNTING

17. Should the first trunk in the group in which the selector is hunting be idle, the L relay releases as the switch leaves position 6 1/4. When the switch enters position 6 1/2, ground is connected to the sleeve of the selected trunk through the outer contacts of cam M, break contact of the L relay, lower outer and upper inner contacts of cam E, as a busy condition until the switch advances to position 7 3/4.
18. Should the first trunk in the group in which the selector is hunting be busy, the L relay is held operated in a circuit from battery through its inner winding and make contact, lower outer and upper inner contacts of cam E, to ground on the sleeve terminal of the busy trunk. With the switch in position 7, the UP magnet is re-operated from ground on cam M under control of the L relay and the selector travels upward until an idle trunk is found. When an idle trunk is found, the locking circuit through the inner winding of the L relay is opened, but the relay does not release immediately due to a circuit being closed from battery through its outer winding inner contacts of cam R, to ground through the C commutator brush and segment. When the brushes are centered on the trunk terminals, the circuit through the C commutator segment is opened and the L relay releases, in turn opening the circuit through the UP magnet, which stops the selector brushes on the terminals of the selected trunk. The L relay released also advances the switch to position 8.

#### "C" COMMUTATOR

- 18.1 The adjustment of the C commutator brush, with relation to the tripped sleeve multiple brush, is such, that it does not break contact with the C commutator segment until slightly after the holding circuit through the inner winding of the L relay is opened, by the sleeve brush leaving the busy terminal and making contact with the sleeve terminal of the idle trunk. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the trunk terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time the other holding circuit through the outer winding of the L relay is opened at the C commutator, releasing the relay, which disconnects ground from the commutator feed bar (G), and releases the UP magnet. The selector then drops into place, thus centering the



July 7, 1921.

brushes on the trunk terminals. During trunk hunting, in position 7 only, the commutator feed ground is supplied from ground on cam M, under control of the L relay. This is to prevent the re-operation of the L relay by the closing of a circuit between the C commutator brush and segment, on the overthrow of the selector, as it drops into place.

19. As the switch advances from position 7, ground on cam H is removed from the fundamental ring (FR) lead, and in position  $7 \frac{3}{4}$ , ground through the upper contacts of cam E is connected to the sleeve of the selected trunk as a busy condition. With the switch in position 8, a circuit is closed from ground on the armature and make contact of the CH relay, through the lower outer and upper inner contacts of cam O, upper outer and lower inner contacts of cam R, to battery through the outer winding of the L relay, which operates, advancing the switch to position 9. In position 9, the tip and ring sides of the outgoing fundamental circuit are closed to the tip and ring terminals of the selected trunk for selection beyond, through the FT and FR brushes of the sender selector and cams F and G, respectively. After selection beyond has been completed, ground in the sender is removed from the SC lead, releasing the CH relay, in turn releasing the L relay. The L relay released, advances the switch to position 10. As the switch leaves position  $9 \frac{1}{2}$ , the dialing circuit is opened at the upper inner contact of cams P and Q, and in position  $9 \frac{3}{4}$ , the tip and ring leads from the line finder are closed through the lower contacts of cams P and Q, respectively, to 24 volt battery and ground in the district, holding the DC relay operated under the control of the station switchhook. With the DC relay operated, a locking circuit is closed for the D relay after the switch advances from position 10. This circuit is traced from battery through the inner winding of the D relay, make contact of the DC relay, make contact of the D relay, to ground through the lower outer contact of cam I. The D relay (178-AK) is made slow in releasing in order that the connection may not be lost if the switchhook at the called station is momentarily depressed. With the switch in position 10, the sender circuit functions and connects ground to the FT lead, causing the L relay to operate and lock through its inner winding over the tip of the fundamental circuit previously described. The L relay operated, advances the switch for talking selection until the relay is released by the operation of the sender circuit. As the switch advances, ground is intermittently connected to the tip side of the fundamental circuit through the outer contacts of cam E, holding the L relay operated, but successively short circuiting and permitting the re-operation of the stepping relay in the sender circuit. When sufficient impulses have been sent back to satisfy the sender,



the fundamental circuit is opened, releasing the L relay. The L relay released, opens the circuit through the R magnet, stopping the switch in position 11, 12 or 13, depending upon the class of call. As the switch leaves position 10, the holding circuit of the CI relay is transferred from ground on cam I to ground on cam E, under the control of the L relay. This circuit is traced from battery through the outer winding of the CI relay, inner contacts of cam U, make contact of the CI relay, lower inner and upper outer contacts of cam V, make contact of the L relay, to ground through the lower inner and upper outer contacts of cam E. The release of the L relay opens the holding circuit through the CI relay, disconnecting the sender from the district circuit.

#### CALLER PARTY ANSWERS

20. When the receiver at the called station is removed from the switch-hook, with the switch in position 11 or 12, reversed battery and ground from the incoming circuit operates the CS relay. This circuit is traced from battery over the ring side of the circuit, through the outer contacts of cam G, winding of the repeating coil, outer and lower inner contacts of cam X, (through the winding of the CS relay, upper inner and outer contacts of cam W,) other winding of the repeating coil, outer contacts of cam F, to ground over the tip side in the incoming circuit. The CS relay operated, closes a circuit from ground on the upper outer contact of cam I, through its make contact, outer contacts of cam N, winding of the I relay, to battery through the #3 contact of the 149-J interrupter. When the interrupter contact closes, the I relay operates and locks to the same ground through its make contact. When the #4 contact of the interrupter closes, the operation of the I relay closes a circuit from ground on the interrupter contact to battery through the 500 ohm winding of the CH relay, operating the relay. The CH relay operated, locks through its winding and the outer contacts of cam O, to ground on its make contact and armature and closes a circuit from battery on its make contact for holding the SL relay operated after the D relay releases.

- 20.1 The 149-J interrupter is so connected in the circuit that the operation of the CH relay is delayed for at least two seconds after the CS relay operates. This delay is to prevent the false operation of the CH relay should the CS relay operate momentarily before the called party answers due to any line disturbances.

#### OPERATOR ANSWERS

21. The switch advances to position 13, as described above, and when the operator inserts the plug of an answering cord in the answering jack of the trunk, the CS relay operates on reversed battery and ground



over the trunk. The QS relay operated closes a circuit from the same ground on cam I, through the upper outer and lower inner contacts of cam R, to battery through the outer winding of the L relay, which operates and advances the switch to position 14. With the switch in position 14, the repeating coil and battery are disconnected and the T, and R leads are connected directly to the T, and R brushes of the selector through cam P and Q respectively. As the switch enters position 13-1/2, the L relay locks in a circuit from ground over lead S of the selected trunk, through the upper inner and lower outer contacts of cam E, to battery through the make contact and inner winding of the L relay, and in position 14, the locking circuit through the inner winding of the D relay is transferred from the contacts of the DC relay to the upper contacts of cam J. In position 14, a checking tone circuit is closed over the sleeve of the operator's trunk, inner contacts of cam E, make contact of the L relay, upper contacts of cam V, lower contacts of cam W, 2 m.f. condenser, lower inner and upper outer contacts of cam X, the S brush and terminal at the line finder bank, to ground through the winding of the CO relay for number checking.

#### DISCONNECTION REGULAR CALL

22. When the receiver at the calling station is replaced on the switchhook, the DC relay releases, in turn releasing the D relay. The D relay released, closes a circuit operating the F relay. This circuit is traced from ground on the lower outer contact of cam I, break contact of the D relay, to battery through the 800 ohm winding of the F relay. The F relay operated, disconnects the tip and ring of the trunk from the line and closes a circuit from ground on the N commutator brush and segment, through its make contact, upper inner and lower outer contacts of cam D, to battery through the R magnet, advancing the switch to position 16.
23. On M.R. district circuits, with the switch in position 16, a circuit is closed from battery on the make contact of the CH relay, outer contacts of cam T, through the three 18-AN resistances in parallel, the H brush and terminal at the line finder bank, over lead H, through the break contact of the L relay, to ground through the message register MR, operating the message register. During the message registering period, another line finder selector hunting over the line terminals in the same group will not stop its brushes on the multiple terminals of this line at this time on account of its H relay being shunted by the 5 ohm message register while the H brush of the hunting selector is passing over the H terminal of this line. When the 149-C interrupter contacts I close, a circuit is closed from ground on the make



contacts, through the lower contacts of cam R, to battery through the outer winding of the L relay, operating the L relay. The L relay operated, locks through its inner winding and make contact to ground on cam E. Ground on the II make contacts of the interrupter is closed through the inner contacts of cam Y, make contact of the L relay, outer contacts of cam J, to battery through the inner winding of the D relay, which operates. The D relay operated, advances the switch to position 17 in a circuit from battery through the R magnet, lower outer contact of cam B, make contact of the L relay, inner contacts of cam M, make contact of the D relay, to ground on cam I. In position 17 the A cam advances the switch to position 18.

24. As the switch advances from positions 16 to 18, the circuits through the D, SL, CH and L relays are opened, releasing the relays and the battery for operating the message register is disconnected from lead H. The release of the SL relay disconnects battery from lead S, releasing the CO relay, thus restoring the line circuit to normal. As the switch enters position 17, the release of the D relay closes a circuit operating the DS relay in the line finder circuit. This circuit is traced from ground on the M commutator brush and segment, through the 350 ohm winding of the DS relay, inner contacts of cam N, break contact of the D relay, to battery on the break contacts of the DS relay. The DS relay operated, (a) locks through its make contact and 350 ohm winding to the same ground, (b) closes a circuit through the outer winding of the F relay, thus insuring the relay to hold until both the line finder selector and the district selector have returned to normal, operates the line finder DOWN magnet from ground on its armature, which restores the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from the M commutator segment, releasing the E, DS, and MB relays.
25. With the district switch in position 18, a circuit is closed from ground on the N commutator brush and segment, make contact of the F relay, upper contacts of cam D to battery through the district DOWN magnet, which operates and restores the district selector to normal. As the district selector returns to normal, a circuit is closed from ground on the Y commutator brush and segment, upper inner contact of cam B, to battery through the R magnet, advancing the switch to position 1 or normal. As the switch leaves position 18, the circuit through the DOWN magnet is opened, and after position 18 1/4, the circuit through the outer winding of the F relay is opened, releasing the relay and restoring the circuit to normal.
26. Should the calling subscriber fail to replace the receiver on the switchhook after the called subscriber has disconnected, the release of the CS relay, due to the incoming trunk functioning, operates the



July 7, 1921.

selector time alarm circuit from ground through the upper outer contact of cam I, thereby notifying the switchman of the existing condition.

#### DISCONNECTION TALKING TO OPERATOR

27. With the plug of the answering cord in the trunk jack at the incoming end, ground is connected to the sleeve terminal of the trunk to hold the district L relay operated. If the plug of the cord is removed from the trunk jack before the receiver at the calling station is replaced on the switchhook, the line relay in the trunk circuit will operate, thereby holding the ground on the sleeve terminal of the trunk. When the receiver at the calling station is replaced on the switchhook and the plug of the answering cord is removed from the trunk jack at the incoming end, the DC relay releases, and ground is disconnected from the sleeve of the trunk, releasing the L relay, thus advancing the switch to position 15. As the switch advances from position 14-1/4, the locking circuit through the inner winding of the D relay is opened at cam J, releasing the relay. The D relay released, opens the circuit through the SL relay, which releases, and operates the F relay, which advances the district switch to position 16 from ground on the N commutator brush and segment. In position 16 ground on the armature of the SL relay through the lower contacts of cam D advances the switch to position 17, the A cam advancing it to position 18. In position 16, the CH relay being normal, battery is not connected over lead H to operate the message register in the line circuit, as the call is not chargeable. From this point on, the line finder and district selectors are restored to normal as described in paragraph 24, and 25.

#### DISCONNECTION ON ABANDONED CALLS

##### (a) DISCONNECTION BEFORE LINE FINDER SELECTOR FINDS LINE

28. Should the calling subscriber replace the receiver on the switchhook before a hunting selector finds the line, the L relay in the line circuit releases, removing battery from the H terminal at the multiple bank. Assuming the calling line to be in sub-group A, the release of the L relay releases the RA relay. The TR relay having operated, locks and operates the SFA relay, which operates the LF relay in the line finder circuit and the selector is started hunting, as described in paragraph 5. The selector will therefore travel to the top of the bank and the H brush of the selector makes contact with the terminal of the H comb at the top of the multiple bank. The H relay operates from ground on the break contact and armature of the DS relay, winding of the H relay, outer contacts of



cam Y, H brush of the selector, to battery on the terminal of the H comb, supplied through the 1,000 ohm non-inductive winding of the BA-1 relay and the break contacts of the BA-1, and BA relays. The H relay operated, releases the LF relay, which in turn releases the F relay and opens the circuit through the UP magnet, stopping the selector. The N commutator segment is opened with the selector brush resting on the H comb terminal to prevent the district switch from advancing from normal when the F relay is released by the release of the LF relay. When the F relay releases, the DS relay operates from ground on the X commutator brush and segment, through its 1,000 ohm winding. The DS relay operated, operates the DOWN magnet, restoring the selector to normal.

#### POSITIONS 2 TO 6

29. If the receiver is replaced on the switchhook at the calling station while the district switch is in positions 2 to 6, the dialing circuit is opened at the calling station, causing the sender circuit to function and connect a direct ground, to the SC lead, causing the D relay to release on account of the increased current flowing through the outer winding of the relay. The D relay is connected differentially, but does not release when its inner winding is connected directly to ground and its outer winding connected to ground in series with a resistance. The D relay released, operates the DS relay, which restores the line finder selector to normal, as described in paragraph 24. The D relay released, also opens the circuit through the SL relay, which releases. The SL relay released, disconnects battery from lead S, releasing the CO relay in the line circuit, and advances the district switch to position 6 from ground on its armature and break contact through the lower contacts of cam D. With the district switch in position 6, a circuit is closed from the same ground through the lower inner and upper outer contacts of cam D, to battery through the DOWN magnet, operating the district DOWN magnet, restoring the selector to normal. When the selector reaches normal, ground on the Y commutator brush and segment advances the switch to normal.

#### POSITIONS 7 TO 10

30. Should the receiver be replaced on the switchhook while the district switch is in any of these positions, the line finder circuit is restored to normal, as previously described in paragraph 24. Trunk hunting and selection beyond will take place in the same manner and the advance of the sender circuit advances the switch to position 11. In position 11 the release of D relay releases the CO relay and operates the F relay, which closes a circuit from ground on the N commutator brush and segment, advancing the switch to position 16. In position 16, ground on the armature of the SL relay advances the switch to



position 17, the A cam advancing the switch to position 18. From this point on, the district selector and switch are restored to normal as described in paragraph 25.

ALL SELECTORS IN ONE SUB-GROUP BUSY

31. If all the selectors in sub-group "A", for example, are busy, the CA relay operates over a circuit from ground on the armature of the MB relay in the line finder circuit, through the make contacts of all the other operated MB relays in sub-group "A", over lead CH to the starting circuit, 500 ohm winding of the CA relay, to battery through the 600 ohm resistance (C). The CA relay operated, transfers the circuit through the 600 ohm winding of the TR relay in the trip circuit from the winding of the ST-A relay, to battery through the winding of the SA relay and the break contact of SB relay. When a call is now received, the SA relay operates in series with the 600 ohm winding of the TR relay, in turn operating the ST-B relay. This circuit is traced from battery through the winding of the ST-B relay, make contact of the SA relay, 600 ohm resistance (B), to ground on the armature of the CB relay. The ST-B relay operated, operates the K relay, starts a selector in the "B" sub-group hunting for the calling line and closes a locking circuit through the 1000 ohm winding and make contact of the CA relay. This is to prevent the release of the CA relay should a selector become available in the "A" sub-group while a call is going through the "B" sub-group. If all selectors in sub-group "B" are busy, the operation is similar except that the CB, SB, and ST-A relays now operate. The ST-A relay operated, starts a selector in the "A" sub-group hunting, as explained before.

ALL SELECTORS IN BOTH SUB-GROUPS BUSY

32. If all selectors in both sub-groups are busy, both the CA and CB relays are operated. Should a call be received in either sub-group under these conditions, the corresponding SA or SB relay operates, but neither the ST-B nor ST-A relay will operate as the circuits to ground on the armature of the CA, and CB relays are open. When a call is received in the "A" or "B" sub-group while all selectors are busy, the message register (MR) in the starting circuit operates through the make contact of the SA relay to ground on the armature of the CB relay, if the call is in sub-group "A", or through the make contact of the SB relay to ground on the armature of the CA relay, if the call is in sub-group "B". The message register thus indicates the number of calls which were originated while all the line finder selectors were busy.



### LINE FINDER TIME ALARM

33. If a line finder does not find the subscriber's line within 35 seconds after the receiver at the calling station is removed from the switchhook, an alarm is given in the following manner: When the receiver at the calling station is removed from the switchhook, the line L relay operates, operating the BA relay. The BA relay operated, connects battery to the contact of the 152-D interrupter in the time alarm circuit over a circuit from battery through the outer winding and make contact of the BA relay, lead B, winding of the B (frame) relay in the time alarm circuit, brush and terminal 1 of the START arc of the time alarm selector, break contact of the A frame relay, to the interrupter contact. When the interrupter contact closes, the B relay operates. The A (frame) relay does not operate, however, due to being short circuited by ground on the interrupter. When the interrupter contact opens, the short circuit is removed from the winding of the A relay, which now operates in series with the winding and make contact of the B relay, to ground on the armature of the B relay, thus holding both relays operated. The next operation of the interrupter operates the STP magnet, over a circuit from ground on the make contact of the interrupter, make contact of the A relay terminal 1 and brush of the STEP arc of the selector, to battery through the winding of the STP magnet. When the interrupter contact opens, the STP magnet releases and steps its brushes one step on its back stroke. The selector brushes thus advance one step for each make and break of the interrupter contact, which is of an interval of 7 seconds, until the fifth terminal of the selector is reached when the circuit through the interrupter is opened. When the fifth terminal of the selector is reached, the BA-1 lamp in the trip circuit lights over a circuit from battery on the armature of the A (frame) relay, terminal 5 and brush of the LAMP arc of the selector, lead A, through the make contact of the BA relay, BA-1 lamp, lead C, to ground through the winding of the B (aisle) relay in the time alarm circuit, which operates. The B relay operated, operates the A (aisle) relay. The A relay operated, lights the aisle pilot and main or monitoring board lamps through their respective auxiliary alarm circuits. When the source of trouble is removed and the BA relay in the trip circuit has released, the circuits over leads A, and B are opened, in turn releasing both the frame and aisle A, and B relays, extinguishing the aisle and main or monitoring board lamps and silencing the alarm. The release of the B (frame) relay also closes a circuit from ground on its armature, through terminal 5 and the bridging brush of the RETURN arc of the selector, to battery through the break contact and winding of the STP magnet, which operates and steps the selector brushes to terminal 6, in which position it awaits the next closure of lead B.



July 7, 1921.

34. Should the BA relay release before the fifth terminal is reached by the selector, the A, and B frame relays release. The B relay released, causes the selector to advance to the next normal position, awaiting closure of lead B, as previously described. The operation of the 188-4 key steps the selector brushes to the next normal position by way of the STEP bridging brush and 5, 10, 15 or 20 terminal, as the case may be. If the selector had been at normal position 6, 11 or 16 when the BA relay operated, the operation would have been the same as described for position 1.

#### WIRING OF GROUP DISTRIBUTOR BANK

35. The wiring of the two group distributor arcs of the regular G distributing selector bank, shown on the regular starting circuit, and of the emergency G distributor selector bank, is shown in detail in the circuit associated with the series circuit through the emergency jack and the contacts of the TR, and TR-1 relays for the 15 groups of a panel line finder frame. For a complete frame of 300 lines, the wiring of the terminals for both arcs of each G distributor selector is shown in a table on the drawing. As a trip circuit is divided into two units, A and B, calls originating in the first 10 lines of a group of 20 lines are connected through trip unit A and a terminal and brush of the G arc normally having access to the line finders in sub-group "A". Calls originating in the last 10 lines of a group are connected through trip unit B and a corresponding terminal and brush of the other arc normally having access to the line finders in sub-group "B". This arrangement permits the distributing of the 30 trip circuit A, and B units to sub-groups "A" and "B", respectively, in the starting circuit, so as to give each group an equal preference, thus preventing any one group from having a permanent preference over the other groups. This is accomplished by the G selector being advanced one step to the next group after each call. The series circuit through the contacts of the TR, and TR-1 relays permits the passing of a call through a number of idle groups with the same speed as though the call originated on a line within the group having the preference at that time. Should two or more calls start in two or more groups at the same time, the group nearest the one having the preference at that time will be completed first, because of the series locking arrangement of the TR or TR-1 relay holding the relay of this group locked and releasing the other relays.

36. The TR relay in any group locks from ground through its 600 ohm winding and make contact, jack 10, terminal and brush of the associated arc of the G selector, to battery in the starting circuit through jack 15. The TR-1 relay locks through its 600 ohm winding



and make contact, jack 12, corresponding terminal and brush of the associated G arc, to the starting circuit through jack 16. Jacks 10 and 12 of each group circuit wire to the selector arc terminals and jacks 9, and 11 loop to the next group circuit, so that though the selector may be giving preference to one group, this group being idle, and a call originates in some other group, a circuit is closed back through the intervening jacks and break contacts of the intervening relays of each group until the terminal which the distributor brush is resting on is reached. Assume a call originates in group 15, and is passing through trip unit A and the brushes of the G distributor selector are resting on the first group terminal, which is terminal 1. The locking circuit for the TR relay will be as follows: Through the 600 ohm winding and make contact of the TR relay and jack 10 of group 15, jack 11, break contacts of the TR-1 and TR relays, and jack 10 of group 14 (not shown), through all other groups in the same manner to jack 10 of group 1, terminal 1, and brush of the selector, to jack 15 of the starting circuit. It will be seen that if two calls start at the same time in two different groups causing the TR relays in the two groups to operate together, the call originating in the group nearest the one having the preference of the starting circuit will be completed first. For example, if a call started in group 10, trip unit A, and another in group 15, trip unit A, the operation of the TR relay in the former group would release the TR relay in the latter circuit, but remain locked itself. The magnet of the G selector is operated by ground on the armature of the ST-A or ST-B relay and the brushes advance one step on the release of the selector armature when the ST-A or ST-B relay releases after each call.

#### LINE FINDER DISTRIBUTOR

37. The distributing selectors A, and B shown in detail on "The Selector Start Wire Circuit" are used for distributing calls uniformly to the line finder selectors in sub-groups A, and B respectively.
38. When the number of line finder selectors for a group does not exceed 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-R distributor selectors. Figure 1 shows these selectors wired and equipped for 16 line finder selectors for each sub-group. When the operation of the ST-A relay in the starting circuit connects ground on the start (ST) lead, as described in paragraph 5, the LF relay which operates depends upon the terminal on which the A-1 bridging brush is resting. Assume the A-1 brush is resting on terminal 1 in the regular start circuit of sub-group A. In this case if the first selector is not busy the associated LF relay operates and functions as previously described. If the first selector is busy, the associated MB relay will be operated and the circuit through the LF relay will be open. In this case the LF relay associated with the next idle selector will operate. Assuming this to be the tenth selector, a circuit is then



July 7, 1921.

closed from ground at the ST-A relay (not shown) through the break contacts of the GA and C relays, the A-1 bridging brush and terminal 1 of the A-1 arc of the distributor selector, the ST lead, make contact of the first MB relay, the series make contacts of the succeeding operated MB relays, break contact of the tenth MB relay, to battery through the inner winding of the LF relay (not shown) which operates. The operation of the GA relay, as described in paragraph 5, operates the STP-A magnet from ground on the armature of the ST-A relay, through terminal 1 and the A-3 brush, to battery through the winding of the magnet, so that when the GA relay releases on the completion of a call, the STP-A magnet releases, in turn stepping the selector brushes one step and giving the next selector the preference. When the brushes of the distributor selector advance from the terminals of the last line finder selector terminal 16, the selector is advanced over the spare terminals to the first terminal from ground on the strapped spare terminals through the A-2 brush. While the selector is advancing over the spare terminals, a call at this time will be routed to the first selector through the A-1 brush and strapped spare terminals by the strap from terminal 22 to terminal 1 on the A-1 arc.

39. When the number of line finder selectors for a group exceeds 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-P distributor selectors. Figure 2 shows these selectors wired and equipped for 26 line finder selectors for each sub-group. It will be noted that the ST leads from the first 15 line finder selectors of each sub-group are connected in their respective order to the first 15 terminals of the A-1 and B-1 arcs and the ST leads of the last 11 line finder selectors of each sub-group are connected in their respective order to the first 11 terminals of the A-4 and B-4 arcs. It will also be noted that the brushes of the first three arcs of each selector are in the opposite position from the brushes of the last three arcs, so that only three brushes of a selector will be making contact with terminals at the same time, the other three brushes being open at that time. On a regular call in sub-group A, the circuit functions as described for Figure 1 until the first three brushes of the A distributor selector advance from terminals 22. At this time the first three brushes are open and the last three brushes are now resting on the first terminal of the A-4, A-5 and A-6 arcs. The next call in this sub-group will then start 17 selector, if idle, hunting for the calling line. Assume the last three brushes are resting on terminal 11 of the associated arcs and the 26 line finder selector is idle. The operation of the ST-A relay in the starting circuit closes a circuit from ground on its armature, break contact of the GA and C relays, A-4 brush and terminal 11,



over the ST lead, through the break contact of the MB relay of the last or 26 line finder selector in the sub-group, to the associated LF relay. The operation of the GA relay operates the STP-A magnet through the A-6 brush and terminal 11. The release of the ST-A relay releases the STP-A magnet, advancing the brushes to the next or terminal 12. Ground on spare terminals 12 to 22 through the A-5 brush advances the brushes of the selector until the first three brushes are resting on the first terminal of the A-1, A-2 and A-3 arcs. While the selector is advancing over the spare terminals, a call at this time will be routed to the first selector through the A-4 brush and strapped spare terminals by the strap to terminal 1 of the A-1 arc.

40. The number of line finder selectors for a sub-group may thus be arranged by changing the necessary strapping on the selector arcs. The operation for the emergency selector for sub-group "A", and the regular and emergency selectors for sub-group "B" are similar.

#### ANOTHER SELECTOR RETURNS TO NORMAL WHILE A CALL IS GOING THROUGH

41. When the ST-A relay operates on a regular call, ground is connected to the line finder circuit over lead X so that when the MB relay operates it is held operated through its outer winding from battery on the armature of the SL relay. This locking circuit prevents the MB relay from releasing, should a selector return to normal while a call is going through, until the call is safely started. There is the possibility that a circuit may have been closed from ground on the armature of the ST-A relay, through the make contacts of several MB relays, to an LF relay associated with some other line finder, but the GA relay in the starting circuit not having had time to operate and open the ST lead. Then if an intermediate MB relay released, due to the associated line finder selector returning to normal, it would find ground on the ST lead and operate a second LF relay, thereby starting two line finder selectors for the same call.

#### TESTING LINE FINDER SELECTORS

42. This circuit, which is shown associated with the starting circuit, enables the testing of any particular line finder selector at any time. The test line used with the test box circuit for making the test is the first or bottom line of the bottom bank in both the "A" and "B" sub-groups, the first line terminals in both sub-groups being connected together.
43. When the 184 plug (shown on the line finder circuit) is inserted in the TEST jack of the line finder under test, the ST and ST-1 leads are connected together. The 1000 ohm winding of the LF relay is



July 7, 1921.

disconnected from the break contact of the MB relay and connected to the make contact of the C relay in the starting circuit through the strapped ring and sleeve of the TEST plug. When the plug of the test box cord is inserted in either 159 test jack, the A relay operates from ground on the sleeve of the test box cord. The A relay is quick in operating to precede the TR relay in the trip circuit on a simultaneous call. The A relay operated, opens the circuit through the 700 ohm windings of the TR and TR-1 relays in the trip circuit and connects ground to the winding of the B relay, which operates. This circuit is traced from ground on the right inner armature of the A relay, winding and break contact of the B relay, break contacts of the ST-A and ST-B relays, to battery on the armature of the STP-G magnet when the previous step of the G distributor selector has been completed. The B relay is slow in operating to prevent a call which has just reached the ST-A or ST-B relay from being interrupted and there being the possibility of two selectors arriving on the test line. The B relay operated, (a) locks to battery on its make contact, (b) operates the C and Cl relay from ground on its armature, through the break contact of the E relay, (c) closes the ring side of a loop through the test box, which operates the L relay associated with the test line. The C relay operated (a) transfers the circuit for operating the ST-A relay in the starting circuit from the G distributor selector bank, (b) opens the normal ST lead, (c) closes the circuit through the LF relay and TEST jack to the make contact of the ST-A relay, as herein-after described, (d) opens the operating circuit for the ST-B relay, which would otherwise operate and lock on a call within the last 10 lines in the group. The Cl relay operated, (a) closes a circuit for operating the TR relay in the trip circuit from battery on the armature of the STP-G magnet, (b) connects the K lead of sub-group "A" with the K lead of sub-group "B", thus connecting the K commutator segments of all the selectors of both sub-groups together, (c) connects the Y lead of sub-group "A" with the Y lead of sub-group "B", so the CA relay will be operated by a selector in either sub-group.

44. The L relay of the test line operated, in turn operates the BA relay. The BA relay operated, operates the TR relay through its 700 ohm winding over the same circuit as described in paragraph 5, except this time through the make contact of the Cl relay, the A relay being operated. The TR relay operated, functions as previously described and locks in a circuit traced from ground through its 600 ohm winding and make contact, make contact of the C relay, break contacts of the CA and SB relays, to battery through the winding of the ST-A relay, which operates. The ST-A relay operated, functions as described in paragraph 5 and in addition closes a circuit operating the D relay. The circuit for operating the LF relay of the line finder circuit under test is traced from ground on the armature and



inner make contact of the ST-A relay, through the break contact of the GA relay, make contact of the C relay, sleeve and ring of the TEST jack and plug in the line finder circuit, to battery through the 1000 ohm winding of the LF relay. The LF relay operated, starts the selector hunting for the battery on the H terminal of the test line, as in the case of a regular call. With the exceptions already stated, the line, trip, starting, line finder and district circuits function as for a regular call.

45. When the ST-A relay operates, the circuit for operating the D relay is traced from ground on the armature and outer make contact of the ST-A relay, break contact and winding of the D relay, to battery on the armature of the B relay. The D relay operated, locks to ground on the armature of the A relay. When the ST-A relay releases, the E relay operates from ground on the left inner armature of the ST-A relay, make contact of the D relay, to battery through the break contact and winding of the E relay. The E relay operated, (a) locks to ground on the armature of the A relay, (b) releases the C and Cl relays, thereby restoring the starting circuit to normal, (c) closes the circuit from battery on the armature of the STP-G magnet, which was opened by the operation of the A relay and later closed by the operation of the Cl relay, through to the 700 ohm windings of the TR and TR-1 relays. When the plug of the test box cord is removed from the test jack, the A relay is released, releasing the B, D and E relays, thereby restoring the test circuit to normal.

#### TELL TALE - LINE FINDER SELECTOR

46. Should the selector travel to the tell tale position while hunting, due to the multiple brush not being tripped, the F relay remains operated through its outer winding. Ground on the X commutator brush and segment is thereby connected to the lead "To Tell Tale Circuit", giving a visual signal to the attendant. As the H commutator segment is open at tell-tale, the district is prevented from advancing from its normal position. The selector in this case is restored to normal manually by the attendant.
47. Should the selector travel to the tell-tale position while hunting, with the multiple brush tripped, a circuit is closed from battery in the trip circuit through the 500 ohm winding of the O relay in parallel with the 500 ohm resistance, make contact of the BA relay, terminal of the H comb at the top of the multiple bank, H multiple brush of the line finder selector, outer contacts of cam Y, winding of the H relay, to ground on the armature of the DS relay, operating the O and H relays. The O relay operated, opens the locking circuit of the K relay and the H relay operated, releases the LF relay, which in turn releases the F relay and UP magnet. The F relay released, opens the circuit



(33 Pages) Page #26.  
Issue 1 - BT-501003.  
July 7, 1921.

through the tell-tale alarm and connects ground through the X commutator brush and segment to battery through the 1000 ohm winding of the DS relay, which operates, in turn operating the DOWN magnet, restoring the selector to normal. The receiver at the calling station being still removed from the switchhook, the L and BA relays are still operated and the call again goes through as described under "ORIGINATING CALL".

#### TELL TALE-DISTRICT SELECTOR

*See Appendix Revision 2*

48. Should the selector travel to the tell tale position during selection, ground on the X commutator brush and segment is connected through the lower inner contact of cam B, to battery through the R magnet, advancing the switch to position 18. In position 18, the DOWN magnet operates and restores the selector to normal. When the selector returns to normal, ground on the Y commutator brush and segment advances the switch to position 1.

#### OVERFLOW

49. If all the trunks in the group are busy, the district selector, while trunk hunting in position 7, will travel to the top of the group and rest on the overflow terminals. As the sleeve terminal at overflow is open, the L relay releases, in turn advancing the switch to position 8. In position 8, the L relay re-operates from ground on the armature of the CH relay, advancing the switch to position 9. In position 9, a circuit is closed from ground on the Z commutator brush and segment, through the upper contacts of cam K, to battery through the R magnet, advancing the switch to position 10. In position 10, a circuit is closed from ground on the Z commutator brush and segment, through the upper outer contact of cam K, lower inner contact of cam L, to battery through the 1200 ohm winding of the L relay, operating the L relay. The L relay operated, locks through its 1200 ohm winding and make contact to the same ground, through the upper outer contact of cam L, advancing the switch to position 14, from ground on cam M. As the switch advances from position 13, the L relay releases, and in position 14 advances the switch to position 15. The release of the L relay also releases the CI relay, disconnecting the sender from the district circuit. With the switch in position 15, a circuit is closed from the "Miscellaneous Tone Circuit" over lead C, 2 M.F. condenser, upper contacts of cam G, winding of the repeating coil, 2 M.F. condenser, upper outer and lower inner contacts of cam W, upper contacts of cam V, lower outer and upper inner contacts of cam J, make contact of the D relay, to ground on cam I. A tone is therefore induced in the other winding of the repeating coil, thus



causing the "All Trunks Busy" tone to be sent back to the calling subscriber. When the receiver at the calling station is replaced on the switchhook, the DC relay releases, opening the locking circuit through the D relay, which releases. From this point on, the switch is advanced to position 1 as described for a regular call.

#### O COMMUTATOR

50. The function of the "O" commutator segment is to maintain an idle condition on the multiple overflow terminals, so that more than one selector may stop on overflow at one time; otherwise the first selector reaching overflow would make the sleeve multiple terminals busy, thus causing succeeding selectors to continue upward into the next group of trunks. The "O" commutator segment is open at overflow, but the S bar is continuous. Both the "O" and "S" commutator brushes are permanently strapped together and wired to the multiple sleeve brush. When the selector is at overflow, the "O" commutator brush is resting on an open (dead) segment and, as the busy ground is fed through the "O" commutator bar only, this arrangement maintains a non-busy condition on the sleeve terminals. When necessary to combine two or more groups of trunks, the multiple sleeve overflow terminals between the combined groups are made permanently busy by being connected to ground. As the "S" commutator bar is closed at overflow, the L relay is held operated at this time, and the selector therefore hunts past the "made busy" terminals into the next group.

#### TERMINATING CALL

51. When a final selector connects to the tip, ring and sleeve terminals of an idle line at the final multiple, battery through a resistance in the final circuit is connected over the sleeve lead S, to ground through the both windings of the CO relay on individual lines and the last line of a group of consecutive lines; or through the 100 ohm winding of the CO relay on an intermediate line of a group of consecutive lines. The CO relay operated, disconnects the L relay battery bridge from across the tip and ring of the line circuit. When the final selector returns to normal, the circuit through the windings of the CO relay is opened, releasing the relay and restoring the circuit to normal.







CIRCUIT REQUIREMENTS

MECHANICAL REQUIREMENTS

- 203-A (CS)
- (a) Armature travel .015" to .020".
  - (b) Armature must move freely in bearings.
  - (c) There must be follow in the contact springs.
  - (d) There shall be .005" air gap between the hard rubber bridge and the swinging spring.

ELECTRICAL REQUIREMENTS

OPERATE

NON-OPERATE

RELEASE

178-AK Test .047 amp.  
(D) Readj. .044 amp.  
Inner  
winding  
(500 ohms)

Test .0038 amp.  
Readj. .004 amp.

Outer Test .046 amp.  
winding  
(500 ohms)

203-A When the trunk loop  
(CS) does not exceed  
3560 ohms resistance.  
Test .004 amp.  
Readj. .0024 amp.

On open circuit:

When the trunk loop  
is more than 3560  
ohms but does not  
exceed 5000 ohms re-  
sistance.

On open circuit:

Test .0032 amp.  
Readj. .0024 amp.

When the trunk loop  
exceeds 5000 ohms  
resistance.

On open circuit:

Test .0026 amp.  
Readj. .0024 amp.



(33 Pages) Page #29.  
 Issue 1 - BT-501003.  
 July 7, 1921.

# CIRCUIT REQUIREMENTS

## OPERATE

## NON-OPERATE

## RELEASE

NOTE: TRUNK LOOP includes the resistance of the trunk conductor, relays and repeating coils, in the district and connecting circuits.

B1  
 (DC) After a soak of approximately .3 amp.  
 Test .021 amp.  
 Readj. .015 amp.

After a soak of approximately .3 amp.  
 Test .0037 amp.  
 Readj. .005 amp.

B9  
 (B) After a soak of approximately .3 amp.  
 Test .063 amp.  
 Readj. .054 amp.

After a soak of approximately .3 amp.  
 Test .003 amp.  
 Readj. .006 amp.

E106  
 (SA,SB) Test .035 amp.  
 Readj. .030 amp.

Test .014 amp.  
 Readj. .015 amp.

E399  
 (D) Test .028 amp.  
 Readj. .013 amp.

Test .0019 amp.  
 Readj. .002 amp.

E428  
 (C) Through relay winding:  
 Readj. .016 amp.  
 Through parallel combination with E568 relay.  
 Test .039 amp.  
 Readj. .034 amp.

Through relay winding:  
 Readj. .010 amp.  
 Through parallel combination with E568 relay.  
 Test .0195 amp.  
 Readj. .021 amp.

E461  
 (A) Test .013 amp.  
 Readj. .012 amp.

Test .0075 amp.  
 Readj. .008 amp.

E461  
 (B) Test .014 amp.  
 Readj. .012 amp.

Test .0075 amp.  
 Readj. .008 amp.

E533  
 (L) Test .0178 amp.  
 Readj. .017 amp.

Test .0114 amp.  
 Readj. .012 amp.

Inner  
 Winding  
 (1200  
 ohms)



CIRCUIT REQUIREMENTS

OPERATE

NON-OPERATE

RELEASE

Outer Winding  
(800 ohms) Test .045 amp.

NOTE: Relay to be equipped with special armature stop  
(piece part 163914).

E555 (A,I) Test .012 amp.  
Readj. .009 amp.

Test .0006 amp.  
Readj. .0013 amp.

E568 (C I) Through relay winding:  
Readj. .015 amp.

Through relay winding:  
Readj. .009 amp.

Through parallel combination with E428 relay.  
Test .038 amp.  
Readj. .032 amp.

Through parallel combination with E428 relay.  
Test .018 amp.  
Readj. .019 amp.

E632 (TR,TR-1) Test .048 amp.  
Outer Wdg. (700 ohms) Readj. .045 amp.

Test .020 amp.  
Readj. .022 amp.

Inner Wdg. Hold:  
(600 ohms) Test .039 amp.

E637 (CA,CB) Test .032 amp.  
Inner Wdg. (500 ohms) Readj. .025 amp.

Test .014 amp.  
Readj. .015 amp.

Outer Wdg. Hold:  
(1000 ohms) Test .041 amp.

E638 (ST-B) Test .027 amp.  
Readj. .025 amp.

Test .0038 amp.  
Readj. .004 amp.



(33 Pages) Page #31.  
Issue 1 - BT-501003.  
July 7, 1921.

CIRCUIT REQUIREMENTS

OPERATE

NON-OPERATE

RELEASE

E639 Test .016 amp.  
(GA,GB) Readj. .015 amp.

*See App. Rev. 2.*

Test .0028 amp.  
Readj. .003 amp.

E686 Test .029 amp.  
(SL) Readj. .015 amp.

Test .0085 amp.  
Readj. .009 amp.

E748 Test .027 amp.  
(LF) Readj. .025 amp.  
Inner Wdg.  
(1000  
ohms)

Test .015 amp.  
Readj. .016 amp.

E750 Test .030 amp.  
(MB) Readj. .028 amp.  
Inner Wdg.  
(1000  
ohms)

Test .013 amp.  
Readj. .014 amp.

Outer  
Wdg.  
(1000  
ohms)

Hold:  
Test .042 amp.

E895 Test .030 amp.  
(E) Readj. .015 amp.

Test .0028 amp.  
Readj. .003 amp.

E896 Test .050 amp.  
(B) Readj. .047 amp.

Test .0065 amp.  
Readj. .007 amp.

E897 Test .028 amp.  
(A) Readj. .013 amp.

Test .007 amp.  
Readj. .0075 amp.

E899 Test .028 amp.  
(ST-A) Readj. .026 amp.

Test .0047 amp.  
Readj. .005 amp.

E901 Test .019 amp.  
(L) Readj. .018 amp.

Test .0049 amp.  
Readj. .0052 amp.

E904 Test .037 amp.  
(E) Readj. .031 amp.

Test .0028 amp.  
Readj. .003 amp.



CIRCUIT REQUIREMENTS

OPERATE

NON-OPERATE

RELEASE

E915      Test .041 amp.  
(F)      Readj. .039 amp.  
Inner Wdg.  
(1000 ohms)

Test .026 amp.  
Readj. .028 amp.

Outer Wdg. Test .042 amp.  
(800 ohms)

E996      Test .042 amp.  
(DS)      Readj. .040 amp.  
Inner Wdg.  
(1000 ohms)

Test .0065 amp.  
Readj. .007 amp.

Outer Wdg. Test .091 amp.  
(350 ohms)

E1027      Test .047 amp.  
(CI)      Readj. .040 amp.  
Inner Wdg.  
(800 ohms)

Test .019 amp.  
Readj. .020 amp.

Outer Wdg. Test .046 amp.  
(800 ohms)

E1148      Test .032 amp.  
(BA,BA-1) Readj. .022 amp.  
Inner Wdg.  
(1000 ohms)

Test .011 amp.  
Readj. .012 amp.

E1149      Through relay wind-  
(O,O-1)      ing:  
Inner Wdg. Readj. .015 amp.  
(500 ohms) Through parallel  
combination with  
500 ohm non-in-  
ductive resistance.  
Test .034 amp.  
Readj. .032 amp.

Through relay wind-  
ing:  
Readj. .010 amp.  
Through parallel  
combination with  
500 ohm non-in-  
ductive resistance.  
Test .020 amp.  
Readj. .021 amp.

Outer Wdg. Hold:  
(1500 ohms)      Test .0285 amp.  
Readj. .027 amp.  
Maximum Armature Travel - .018".



(33 Pages) Page #33.  
Issue 1 - BT-501003.  
July 7, 1921.

CIRCUIT REQUIREMENTS

OPERATE

NON-OPERATE

RELEASE

E1187  
(CO)  
Windings  
in series

Test .0116 amp.  
Readj. .011 amp.

Test .007 amp.  
Readj. .0074 amp.

Inner Wdg.  
(105 ohms)

Test .078 amp.

E1321  
(CH)  
Inner  
winding  
(500 ohms)

Test .027 amp.  
Readj. .025 amp.

Test .0023 amp.  
Readj. .003 amp.

E1325  
(H)

Test .0095 amp.  
Readj. .009 amp.

Test .0064 amp.  
Readj. .0068 amp.

Minimum front contact follow: .008 inch  
Armature travel, minimum .020 inch, maximum .023 inch.

F10  
(K, K-1)

After operating on .047 amp., relay must remain operated when the circuit is broken for a minimum period of 0.1 second and release on open circuit within a time interval of 0.3 second.

SM Message  
Register

Test .036 amp.

Test .032 amp.

53 Message  
Register

Test .330 amp.

Test .270 amp.

SPL Mes-  
sage  
Register  
D-20060

Test .030 amp.

Test .025 amp.

ENG.--WCD-ML.  
9-17-24.

CHK'D.--WHL-CWP.

APP'D.--C.L. SLUYTER, G.M.L.